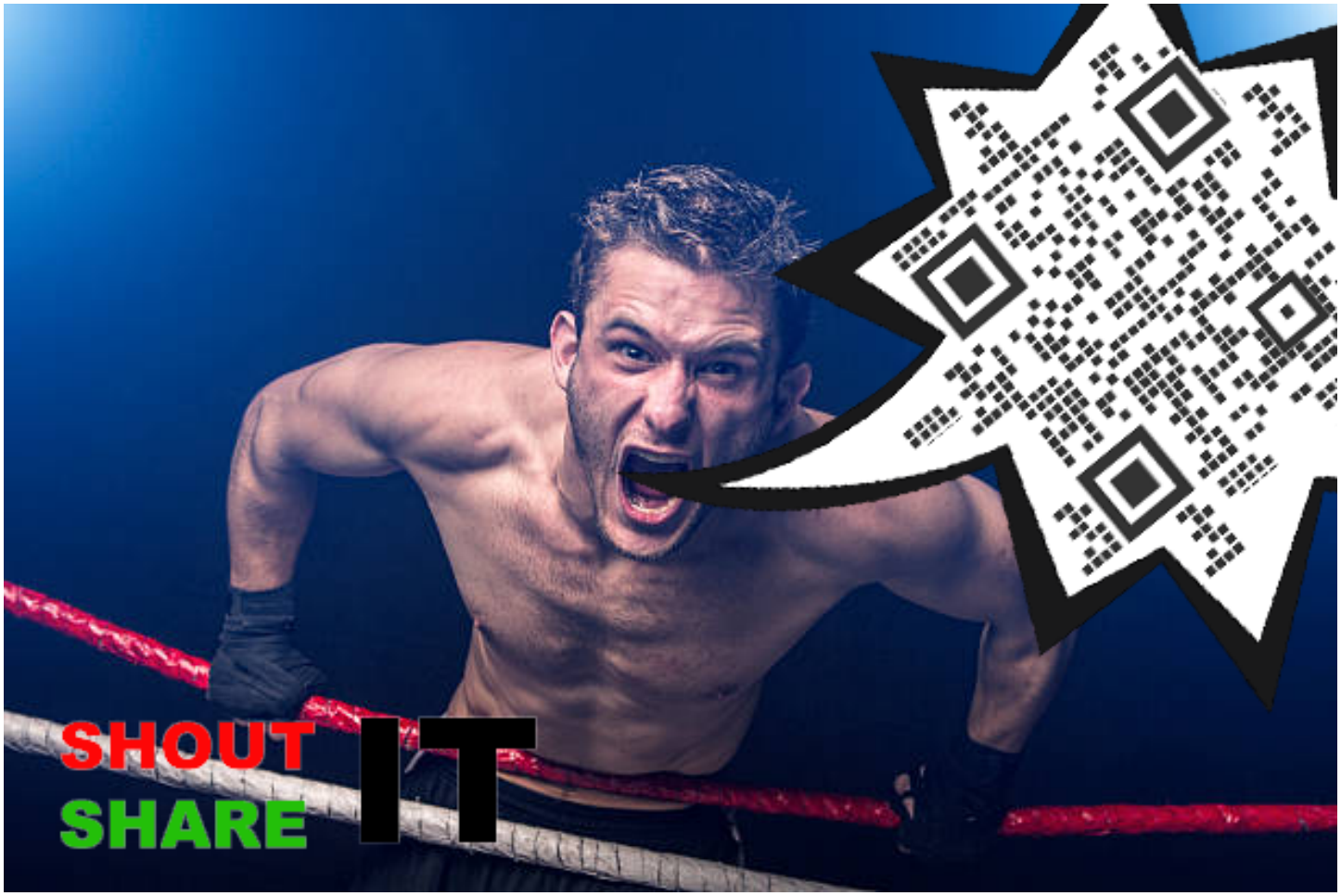
Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.


SHOUT
SHARE
IT

714

PORTO RICO AGRICULTURAL EXPERIMENT STATION,

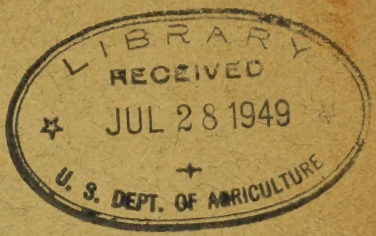
FRANK D. GARDNER, Special Agent in Charge,

Mayagüez, May, 1904.

1
E46 5B
cop. 3

REYNOLDS LIBRARY

Bulletin No. 4.



Propagation and Marketing of Oranges in Porto Rico.

BY

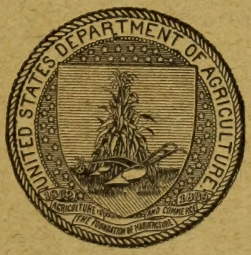
H. C. HENRICKSEN,

Assistant Horticulturist, Porto Rico Agricultural Experiment Station.

UNDER THE SUPERVISION OF

OFFICE OF EXPERIMENT STATIONS,

U. S. DEPARTMENT OF AGRICULTURE.



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

PORTO RICO AGRICULTURAL EXPERIMENT STATION,

FRANK D. GARDNER, Special Agent in Charge,

Mayagüez, May, 1904.

Bulletin No. 4.

Propagation and Marketing of Oranges in Porto Rico.

BY

H. C. HENRICKSEN,

Assistant Horticulturist, Porto Rico Agricultural Experiment Station.

UNDER THE SUPERVISION OF

OFFICE OF EXPERIMENT STATIONS,

U. S. DEPARTMENT OF AGRICULTURE.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

PORTO RICO AGRICULTURAL EXPERIMENT STATION.

[Under the supervision of A. C. True, Director of the Office of Experiment Stations, United States Department of Agriculture.]

STATION STAFF.

FRANK D. GARDNER,[a] *Special Agent in Charge.*
O. W. BARRETT, *Entomologist and Botanist.*
J. W. VAN LEENHOFF, *Coffee Expert.*
J. VAN LEENHOFF, Jr., *Tobacco Expert.*
H. C. HENRICKSEN, *Assistant Horticulturist.*
E. F. CURT, *Farm Superintendent.*
EDWARD C. HOWE,[b] *Clerk and Stenographer.*

---

[a] Succeeded by D. W. May, May 1, 1904. [b] Succeeded by Jessie F. Springer, May 1, 1904.

Withdrawn
8/12/48

LETTER OF TRANSMITTAL.

AGRICULTURAL EXPERIMENT STATION,
Mayagüez, P. R., May 16, 1904.

SIR: I have the honor to transmit herewith a bulletin on propagation and marketing of oranges in Porto Rico, by Mr. H. C. Henricksen, assistant horticulturist of this station, and respectfully recommend its publication as Bulletin No. 4 of the Porto Rico Experiment Station.

The growing of oranges and other citrus fruits in Porto Rico on a commercial scale has commenced since the American occupation and at the present writing has not gone beyond the experimental stage. The indications, however, are favorable, and on the strength of these considerable areas are being planted. It is estimated that fully 6,000 acres have already been planted to budded trees secured either from Florida or from local nurseries.

The orange as grown in Porto Rico for many years prior to American occupation was propagated only from seeds, and as a result the fruits represent a wide range in characteristics, such as appearance, flavor, number of seeds, "rag" content (tough, indigestible inside fiber), and time of ripening. Some of the fruits are worthless, some are poor, while many are good, and a few are as fine as can be found in either California or Florida. It is from the few trees that produce really choice fruits, adapted to particular uses, that the growers should propagate rather than to plant large areas budded from varieties that are new to Porto Rico, until such time as it is proved that introduced varieties will succeed well.

It is with a view of instructing the small nurserymen and planters throughout the island, or those men who are without experience in propagating and growing oranges and other citrus fruits, that this bulletin has been prepared. No attempt is made to go into fuller details that would be required for the larger nurserymen, who as a rule have already mastered the subject and gained the knowledge and experience that insures success.

By using varieties adapted to our climate, planting on soils suited to the product, in localities that are easily accessible from shipping points, and with proper packing and shipping facilities there is little doubt that orange growing in Porto Rico will prove both successful and profitable.

Very respectfully, FRANK D. GARDNER,
Special Agent in Charge.

Dr. A. C. TRUE,
Director, Office of Experiment Stations,
U. S. Department of Agriculture, Washington, D. C.

Recommended for publication:
A. C. TRUE, *Director.*

Publication authorized:
JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
Propagation by seeds	7
Seed selection	7
Disadvantages of seedling trees	8
Propagation by budding	8
Budding stock	8
The seed bed	9
The nursery	9
Transplanting	10
Selection of bud wood	10
Cutting the scions	10
Budding knife	12
Budding tape	12
How to bud	12
Forcing the buds	14
Planting a grove	15
Preparing the land	15
Staking out the grove	15
Digging the holes	16
Planting the trees	16
Cultivation and manuring	17
Working over old trees	18
Crown grafting	18
Top grafting	19
Top budding	20
Dormant budding	20
Inarching and bridge grafting	20
Marketing	21
Picking and curing	21
Grading	22
Sizing	22
Packing	24
Shipping	24

ILLUSTRATIONS.

PLATES.

Page.

PLATE I. Fig. 1.—Leaf forms of citrus trees: *a*, Rough lemon; *b*, pomelo; *c*, sour orange; *d*, sweet orange; *e*, lime. Fig. 2.—Forms of bud wood: *a*, Young, angular; *b*, round, green; *c*, older, gray-streaked 8

II. Fig. 1.—Method of shield budding: *a*, Cutting the bud; *b*, bud; *c*, making the incision; *d*, bud partly inserted; *e*, bud wrapped. Fig. 2.—Angular sprig budding: *a*, Bud; *b*, bud inserted; *c*, sprig bud; *d*, sprig bud inserted and wrapped 12

III. Fig. 1.—Forcing the buds: *a*, Bud unwrapped and girdled; *b*, bud tied up; *c*, stock cut off. Fig. 2.—Crown grafting, with grafts inserted 14

IV. Fig. 1.—Tree sawed off for top grafting. Fig. 2.—Cleft grafting: *a*, Showing the cleft; *b*, grafts inserted 18

V. Tree pruned for top budding and branches cut off immediately above the buds to show places of insertion 20

VI. Fig. 1.—Dormant budding: *a*, Bud; *b*, piece of bark removed; *c*, bud inserted. Fig. 2.—Bridge grafting and inarching: *a*, *b*, *c*, Bridge grafts; *d*, inarch 20

TEXT FIGURES.

FIG. 1. Pruning and budding tools: *a*, Pruning saw; *b*, large pruning shears; *c*, hand pruning shears; *d*, pruning knife; *e*, budding knife 11

2. Grafts covered up 19

3. Orange sizer 22

4. Showing method of packing oranges (from Florida Sta. Bul. 63) 23

PROPAGATION AND MARKETING OF ORANGES IN PORTO RICO.

INTRODUCTION.

The orange can not be successfully propagated from cuttings, but it is well adapted to the method of seed propagation, as the seeds germinate readily. This method is undesirable, however, as the orange does not reproduce itself true to seed. Therefore, wherever it is grown extensively for commercial purposes it is always propagated by budding or grafting on seedling stocks.

PROPAGATION BY SEEDS.

An abundance of orange trees growing wild in a certain locality will indicate the natural fitness of that locality for orange culture, but does not by any means show that a cultivated orange tree will succeed as well as the wild specimen.

Under natural conditions the fruits drop and the seeds scatter, and if conditions are favorable germination takes place. But out of the thousands of seeds germinating each season only a few seedlings can be found next season, and perhaps a couple of years hence there will be but one or two sturdy specimens left. If those same seeds were planted and cared for nearly all of them would probably grow to maturity, but certainly not all would succeed as well, even under the improved cultural conditions, as the natural selections.

SEED SELECTION.

When a seedling orchard is desired seeds for planting should be selected only from those trees and fruits that possess the characters desired by the grower. The tree should be healthy and vigorous and have but few thorns. It should be isolated as much as possible from other trees in order to prevent cross breeding. The fruit should be well formed and of a uniform size. For the orange, sizes from $2\frac{3}{4}$ to $3\frac{1}{4}$ inches in diameter will answer the market requirements better than smaller or larger sizes. The peel should be thin, but tough and elastic. The rag (a term designating the fiber inclosing the individual segments) should be thin and transparent, and the core should be

small. Of seeds there should be but very few. The taste should be sweet without being insipid, with a rich, delicate orange flavor.

In Porto Rico the time of ripening should be either very early or very late. For early, from September 1 to December 1, and for late, from April 1 to July 1.

DISADVANTAGES OF SEEDLING TREES.

After all the trouble to which the grower may have gone in selecting seeds, the fact still remains that he can not know with certainty what the result will be before the tree grows up and bears fruit. No seedling possesses the absolute inherent characters of the parent plant, although some will reproduce nearly true to seed. In the orange, however, the true reproductive character can not be relied upon and it will often happen, in spite of all the precautions taken, that the fruit of a tree will be far different from the parent fruit from which the seeds were planted many years before.

The seedling tree in Porto Rico usually grows too tall, which greatly increases the cost of picking the fruit. It is very often thorny, making it disagreeable to handle and spoiling a large amount of fruit; besides, the average seedling does not bear at as early an age as the budded trees of most of the named varieties.

PROPAGATION BY BUDDING.

Most of the disadvantages of seedling trees can be eliminated by means of bud propagation of selected varieties, which method is almost exclusively used where citrus fruits are grown for commercial purposes. When budding is to be practiced, seeds from one of the best locally adapted species of the citrus family should be planted for the production of seedlings to bud upon. The resulting plants, called budding stock, may then be budded with any desirable variety of orange.

BUDDING STOCK.

In Florida the following species are used for budding stock: Rough lemon, pomelo, sour orange, sweet orange, and lime (Pl. I, fig. 1).

The rough lemon grows very vigorously, with an extensive but shallow root system. It will grow on land where the sweet orange would perish, and is well adapted to dry and sterile localities, but will also thrive very well on low moist soil.

The pomelo stands next to the rough lemon in vigor; but while it thrives on nearly all kinds of soil, it should not be planted on extremely poor soil nor on that which is excessively wet or dry.

The sour orange is probably the most satisfactory budding stock. Its root system is well balanced, deeper than the pomelo and rough lemon, but with shorter lateral roots. It is probably inferior to the

FIG. 1.—LEAF FORMS OF CITRUS TREES: *a*, ROUGH LEMON; *b*, POMELO; *c*, SOUR ORANGE; *d*, SWEET ORANGE; *e*, LIME.

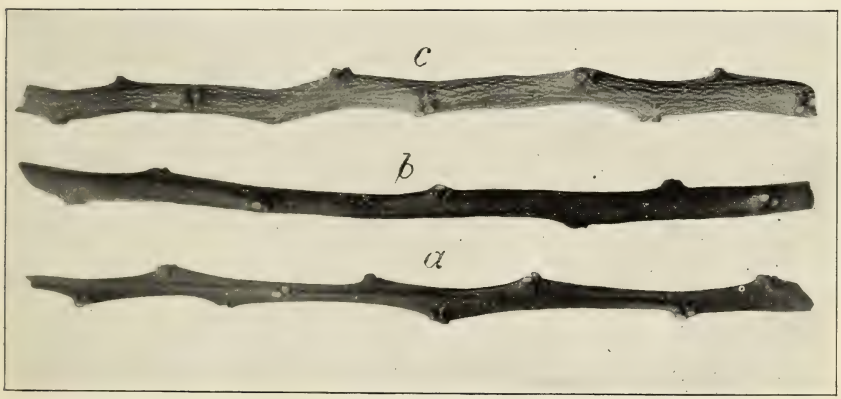


FIG. 2.—FORMS OF BUD WOOD: *a*, YOUNG, ANGULAR; *b*, ROUND, GREEN; *c*, OLDER, GRAY STREAKED.

rough lemon under extreme conditions, and may not be as vigorous. But on low undrained land it should be used in preference to any other as it is practically immune to foot rot, a disease which is often quite severe on sweet orange and which may attack rough lemon and pomelo when planted under those conditions.

The sweet orange can not be recommended for extensive use as budding stock in Porto Rico, as it seems to be of much slower growth there than the rough lemon and pomelo.

The lime is not often used as budding stock and has no merit as such, except in very rocky soil, where it will take root and thrive in crevices where no other citrus tree would live. It should not be extensively planted by beginners in orange culture, as it is difficult to bud.

THE SEED BED.

The seeds intended for planting should be taken from fully ripened, well-developed fruits, gathered from healthy, vigorous trees. The fruits should be cut in halves, the seeds squeezed out, and planted immediately, since drying retards germination. The seed bed should be located on naturally rich, well-drained soil. If such can not be found, a good dressing of stable manure should be applied and well worked into the soil a couple of months before planting.

The seed beds should be laid out 4 feet wide with a 2-foot walk between. The seeds should be planted about one-half inch apart, in rows 6 inches apart, running crosswise in the bed, and covered to a depth of about 1 inch. It is always desirable to have the seed bed located near a permanent water supply, as daily attention may be required. The beds should never be allowed to dry out; the soil should be loosened from time to time and the weeds carefully removed. Under favorable circumstances the plants will be ready for transplanting in six to seven months, having reached a height of 8 to 12 inches.

THE NURSERY.

About the time the seed bed is planted the nursery site should be selected and the soil thoroughly prepared. The land should be cleared and all stumps and rubbish removed, after which a good application of stable manure should be given and the soil plowed deep. Immediately after plowing, a crop of velvet beans should be planted, which will prevent the escape of any of the fertilizing properties in the manure and shade the soil, as well as gather nitrogen, the most expensive ingredient in fertilizers, from the air.

A couple of months before the trees in the seed bed are ready for transplanting, the velvet beans should be mowed down and allowed to wilt, after which the vines should be plowed under. Immediately before planting, the land should be harrowed and thoroughly pulverized.

TRANSPLANTING.

For transplanting, a rainy day should be selected, if possible, in order to prevent wilting and to save hand watering. The seed bed should be thoroughly wet and the trees removed by digging down at one end of the bed to the lowest depth reached by the feeding roots. Then by thrusting a spade horizontally under the trees a considerable number may be removed at one time. If the tap root is excessively long, the lower portion may be cut off. If the soil is clayey it will adhere to the roots, and the trees should be moved to the nursery without being separated. If sandy, the soil will shake off, and the roots should be wrapped in wet sacks or transported to the nursery in barrels containing water.

The rows should be marked off perfectly straight, 3¼ feet (1 meter) apart, and the trees planted at a distance of 13 inches apart (⅓ meter) in the row. The holes for planting may be made with a straight spade or a hard-wood stake 4 feet long and pointed at one end. After the planting the trees should be watered, if necessary, until well established. The nursery should be cultivated frequently so as to check the growth of weeds, as well as the evaporation of soil moisture. On poor soil it may be found necessary to apply some fertilizers in order to push the growth. The trees, under favorable circumstances, should be ready for budding in five or six months.

SELECTION OF BUD WOOD.

In Florida and California about 75 varieties of oranges are recognized, but not more than 20 to 25 are generally cultivated. Only a few of these varieties are in marketable condicion before the last part of November, and fewer still can be held later than April. How they will behave under cultivation in Porto Rico it is yet too early to predict; but as Porto Rico already possesses a great number of unknown seedling varieties, it may be assumed that by judicious selection some varieties may be established which will be equal or even superior to those already known, and if in a certain locality a tree can be found possessing the desired characters there is no reason why it should not be used to propagate from. It can not be too strongly emphasized that every grower should be on the lookout for the best trees that may be found in the neighborhood, always remembering that bud wood cut from a branch bearing good fruit will produce fruit of the same quality when grown on a congenial stock under similar conditions of soil and climate.

CUTTING THE SCIONS.

In the orange the young wood is angular and of a light-green color; but toward maturity it becomes round and the color of the bark changes to a dark green. As the wood grows older the appearance

of the bark will be somewhat rough and the green color will be streaked with light gray, turning to a solid gray when fully mature (Pl. I, fig. 2).

For bud wood the round, dark green wood of the present season's growth is generally preferable, though the older gray-streaked wood may often be used to advantage. The scions may be cut from any part of the tree, except from suckers and water sprouts (that is, sprouts growing directly from the roots or lower part of the trunk). For this work a pair of hand pruning shears will be found convenient (fig. 1*c*). Immediately after cutting, the wood should be divided into

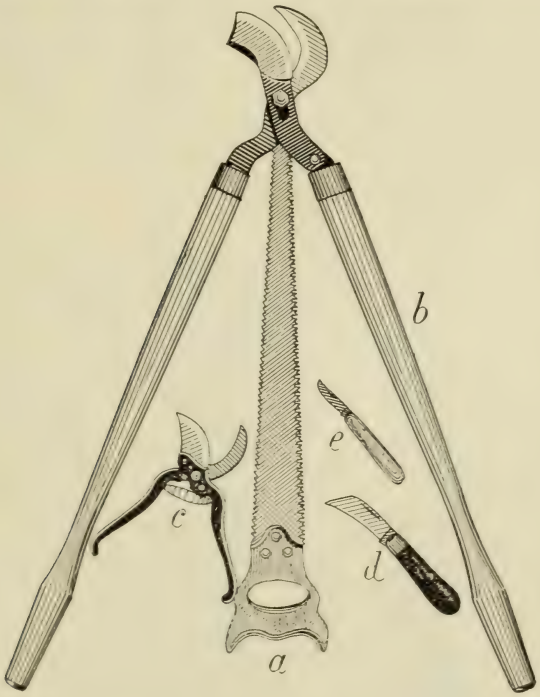


FIG. 1.—Pruning and budding tools: *a*, Pruning saw; *b*, large pruning shears; *c*, hand pruning shears; *d*, pruning knife; *e*, budding knife.

lengths of about 10 inches, and the leaves and thorns at once cut off with a sharp knife, close to the wood, without injuring the bud.

The scions should then be wrapped closely in a wet sack, which should again be wrapped in one or two dry sacks and put away in a cool place for about a week. By that time the petioles will have dropped off, the leaf scars healed over, and the buds will be what the nurserymen call "cured," which means that most of the reserve material in the scion has moved into the buds, rendering them tougher and increasing their longevity, thus making the process of budding easier and insuring better success.

BUDDING KNIFE.

Before starting to bud, a good knife for that purpose should be secured (fig. 1*e*). If it should be found difficult to obtain such a knife, a good thin-bladed pocketknife may be used, if the sharp point is ground off as shown in fig. 1*e*, and it should be borne in mind that a sharp budding knife is the first requisite for successful budding. The budding knife should never be used for trimming, not even for cutting off a thorn, and the edge should always be as keen as a razor's.

BUDDING TAPE.

Budding tape may be made by dipping muslin into a hot mixture of 3 parts of beeswax to 1 part of resin, or 2 parts of beeswax to 2 parts of resin and 1 part of tallow.

A much better tape, however, can be made by dipping muslin in hot paraffin containing a small amount of beeswax (about 1 part beeswax to 8 or 10 parts paraffin).

There are many grades of paraffin and they are not all suitable for this purpose. The paraffin sold at drug stores is generally of a white color with a hard brittle texture, and therefore nonadhesive. It is also expensive. Most of the grades used by match factories on the island will be found suitable; some grades, however, contain free oil and should be avoided on that account. The best grade for budding tape is soft, elastic, semitransparent, and should leave no oil nor greasiness on the fingers after handling.

For melting the mixture a broad receptacle, like a frying pan, should be used. The muslin, about a yard long, may be folded several times and immersed in the melted mixture, where it should remain until thoroughly saturated. If the resin mixture is used the surplus material should be removed by drawing the cloth between two sticks held close together by an attendant. If the paraffin mixture is used the cloth should merely be allowed to drip, after which it should be unfolded and held in the hands a moment until cool; it may then be torn into strips about 12 inches wide. These strips should be nicked with a knife or pair of shears, at intervals of about one-third inch along one side, to facilitate tearing off the strips for wrapping.

HOW TO BUD.

The process of budding consists in cutting from the scion a piece of bark containing an eye or bud and inserting it under the bark of a tree (the stock) through an incision made with the budding knife. Several methods may be employed, but the most common one is shield budding (Pl. II, fig. 1).

To do this work the operator kneels down beside the tree to be budded. Taking the budding knife in the right hand, a vertical cut

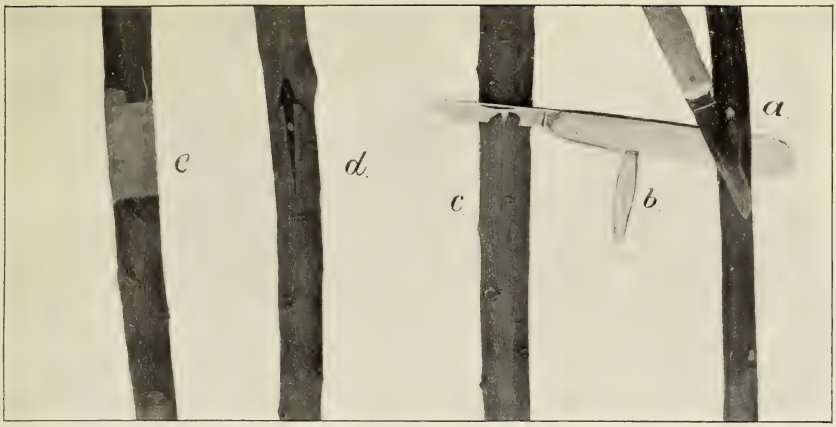


FIG. 1.—METHOD OF SHIELD BUDDING: *a*, CUTTING THE BUD; *b*, BUD; *c*, MAKING THE INCISION; *d*, BUD PARTLY INSERTED; *e*, BUD WRAPPED.

FIG. 2.—ANGULAR SPRIG BUDDING: *a*, BUD; *b*, BUD INSERTED; *c*, SPRIG BUD; *d*, SPRIG BUD INSERTED AND WRAPPED.

about 1½ inches long is made in the bark a few inches from the ground. At the base of this a horizontal cut is made, giving the knife an upward twist to slightly raise the lower edges of the bark.

To properly cut a bud is perhaps the most difficult operation of budding. The cut surface should be perfectly smooth without being split, and the bark should have a thin piece of the wood adhering to it. To successfully accomplish this the scion is held in the left hand with the top end from the body, while with the knife in the right hand the cut is started about one-half inch above the bud, cutting deep enough to remove a thin piece of wood with the bark. The blade of the knife should form an acute angle with the scion and the cut be made by beginning near the base of the blade and drawing the knife backward with a gentle stroke. This separates the bud with a smooth surface and prevents it from splitting off, as it is always inclined to do.

The bud should be inserted from below through the incision made in the bark, and pressed up with the point of the knife until fully covered by the bark. The bud is generally inserted with the eye pointing upward; but that is immaterial, as just as good success can be obtained by inserting with the eye pointing down, and it apparently makes no difference in the growth of the bud. Even a sprig bud may be inserted with the top downward.

Immediately after inserting the bud a strip of waxed tape should be torn off and wrapped tightly around the stock, beginning below the horizontal cut and wrapping upward, letting each turn of tape slightly overlap the preceding one. The bud should be entirely covered, and if the tape is too long it will be easier to take an extra turn around the stock than to cut it off.

If scions have been cut from the angular wood it will be found necessary to vary the method somewhat (Pl. II, fig. 2*ab*). In cutting the bud the scion should be held with the angular edge to one side and the bud on the upper surface. The shield when cut off will then be as broad as if the wood had been round, but the eye will be placed at one side instead of the center. For inserting the bud a vertical incision should be made on the stock by turning the knife to one side, letting the point in under the bark deep enough to loosen it. A pocket will then be made into which the bud should be inserted and wrapped, as previously described.

Another method often used for angular wood is what is called "sprig" budding (Pl. II, fig. 2*cd*). Here a scion containing several buds is used. It is sharpened with a slanting, smooth cut on one side and inserted in a pocket-like receptacle on the stock, like the one described above, and should be wrapped with tape around the insertion, with the last two turns around the stock only, and firmly pressed down behind the sprig.

The buds should be left undisturbed for ten days to two weeks, in which time they will have united with the stock. The tape should then be unwrapped from the top far enough down to expose the eye, but should be left intact below the eye, which will insure keeping the bud in place if not well enough united, and will do no harm, since it drops off in a short time.

In a week's time after unwrapping, the buds should be again inspected, and all that are found to be green should be "forced." That is, the sap flow in the tree should be arrested immediately above the point of budding, in order that most of the sap may flow to the inserted bud.

FORCING THE BUDS.

Forcing may be accomplished by partly cutting the tree off above the bud and lapping the top over, which method is preferred by many nurserymen, though it has many disadvantages. It is exceedingly difficult to force dormant buds in that way; the lapped tops will always be in the way for working; there is no stock left to which the bud may be tied, and therefore stakes will have to be used.

Another and better method is girdling (Pl. III, fig. 1*a*), which consists in cutting the bark all around the stock about 2 inches above the bud, and making another similar cut one-half to three-fourths inch higher up. Then by making a vertical cut between the two, a ring of bark can be peeled off very readily. Some nurserymen cut the stock entirely off after the bud has united, but that is bad practice and should be avoided.

Two to three weeks after girdling the trees should again be gone over and all young growth below the girdle should be cut off, leaving the bud only. This process should be repeated every two weeks until no more growth appears. When the bud has grown to a length of 4 to 5 inches it should be tied to the stock in order to direct a straight growth and to prevent its being broken off (Pl. III, fig. 1*b*). One or more tyings will be necessary later on, always with the object of a straight tree in view. If the buds grow up more than 3 feet high without branching the tips should be nipped off in order to induce branching.

After the bud shoots have reached a diameter of one-half inch or more at the base the old stock should be cut off close above the union. This may be done with a pair of sharp pruning shears. The cut should be slanting from the point of union downward (Pl. III, fig. 1*c*); thus when healed over no scar will be left and the tree will be straight, not even showing the place of union. After the stock scar has healed over the tree will be ready for transplanting.

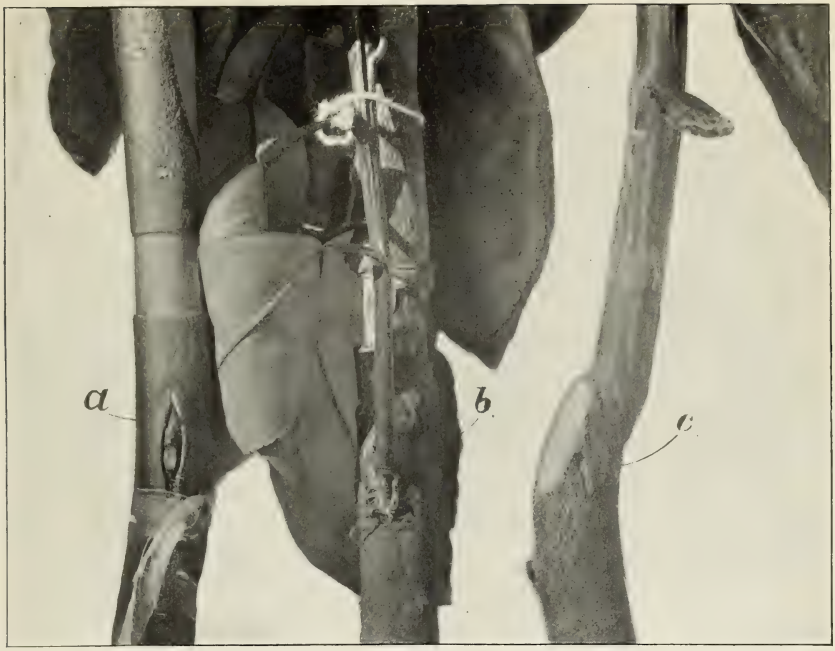


FIG. 1.—FORCING THE BUDS: *a*, BUD UNWRAPPED AND STOCK GIRDLED; *b*, BUD TIED UP; *c*, STOCK CUT OFF.

FIG. 2.—CROWN GRAFTING WITH GRAFTS INSERTED.

PLANTING A GROVE.

PREPARING THE LAND.

In the best orange sections in Florida the land is always cleared of all brush and stumps and plowed once or twice before planting. In Dade County, where the soil is very rocky, it was the practice a few years ago to cut down the large trees, which, together with the small brush, was burned, leaving the stumps in the ground. The rows were then marked off and holes dug or blasted and the trees planted at once. Prospective planters figured out that a small tree would need but a few feet of soil the first year or two, and by clearing a space around each tree, increasing it year by year, the cost would be distributed and the tree grow as well. That, however, was soon found to be a fallacy, and now the land is all well cleared and prepared before planting, and this method will no doubt be found the most economical in Porto Rico.

STAKING OUT THE GROVE.

If undisturbed by disease or climatic influence there is practically no limit to the age of an orange tree, and in Porto Rico the seedling trees attain a diameter of 1 foot or more, with a spread of 25 to 35 feet. The budded tree will probably not reach the same size, but a space of not less than 20 by 25 feet should always be given, and probably more space may be found advisable.

For a small grove procure as many stakes as there will be places for trees. The stakes should be straight, not less than 4 feet long, and painted white at one end. The first line (base line) should be measured off running parallel with the general direction of one side of the field and as close to that side as practicable, and stakes placed the desired distance apart. Next a square corner should be established thus: Begin at one end of the base line and measure off 80 feet along that line, placing a stake at the finishing point; then start from the same end of the base line and measure off 60 feet at a right angle thereto, and set another stake; the distance in a straight line between these stakes should be 100 feet. The 60-foot stake may need to be moved slightly from its trial position; and when the distance is just 60 feet from the base line and 100 feet from the first stake the lines will be exactly at a right angle with each other. Continue the line through the 60-foot stake to the opposite side of field and square that corner in the same way. The other two lines may then be laid off and the corners squared likewise. Stakes may then be placed at the desired distance on those four lines, and no more measurements will be required. The rest of the stakes may be placed by one man, while two men direct him by sighting from each side.

With great care a large orchard may be staked out in the same way, by starting at one corner of the field and measuring off no more at one time than a man can sight across. The lines of the measured-off sections will then be the base line for the adjoining sections.

The following table gives the number of trees per acre when set different distances apart:

Distances and number of trees per acre, for orange trees.

Distance apart.	Number of trees.
20 feet by 20 feet	107
20 feet by 25 feet	86
25 feet by 25 feet	69
25 feet by 30 feet	59
30 feet by 30 feet	48

DIGGING THE HOLES.

It is also economical to enrich the soil before planting, and in Porto Rico it will doubtless pay to dig large holes where the trees are to be planted, which should then be filled with alternate layers of compost and soil. Leaf mold, or even dry grass, may be used instead of compost. The holes should be allowed to stand six to eight weeks before planting the trees, in order that the soil may settle and the heat which will be generated by the compost may be allowed to escape.

After digging the holes the stakes should be placed exactly in the same position as before, which may be accomplished by using a tree setter. A tree setter may be made from a straight board 8 to 10 feet long and about 4 inches wide, with a hole near one end and a notch near the other as well as one in the middle. The tree setter should be placed on the ground with the middle notch placed against a marking stake which has been set in place by sighting as already described. A wooden peg should be inserted through the hole in the board and another in the notch at the other end. Then by swinging the board out of position the marking stake may be removed and the hole dug. By swinging the board into position again the stake can be replaced precisely. The tree setter should again be used when planting the trees.

PLANTING THE TREES.

When ready for planting the trees may be taken out of the nursery in a manner similar to that followed in removing them from the seed bed. If a ball of dirt can be removed with the roots it will be found of advantage to do so. If not, the roots should be carefully covered to prevent drying out. If the planting is done in the rainy season, as it ought to be, the trees may be left untrimmed, but it will usually be found best to cut off part of the top as well as most of the leaves in order to check transpiration.

If a ball of soil adheres to the roots, the tree may be set in the hole to the right depth and the soil thrown in and firmed down. But if the roots are bare, the tree should be carefully set down, the roots spread out, and the soil worked in among them with the hands, after which a generous amount of water should be poured on in order to get every root and rootlet in contact with the soil.

The tree should never be planted deeper than it was in the nursery. After the soil has been firmed around the roots the collar of the tree should stand at least 2 inches above the level of the field. The bed, extending about a foot around the tree, should then be made a few inches higher, with a hollow in the middle, in order to retain water. The tree should be watered, if necessary, during the first six to eight weeks after planting. A heavy mulch of grass or any other similar material applied immediately around the tree will help to preserve the moisture.

CULTIVATION AND MANURING.

The amount and kind of cultivation required by a certain crop will depend chiefly upon the class of soil, in connection with the climatic conditions.

The principal objects of cultivation are to aerate the soil, conserve the soil moisture, and destroy the weeds. When it rains the surface soil will be packed, preventing the air from coming in contact with the roots, as well as allowing the soil moisture to evaporate. By breaking and pulverizing the surface soil the capillary movement of the soil moisture will be arrested and evaporation checked. A large amount of growing vegetation will evaporate more moisture than the bare soil, and should therefore be kept down throughout the dry season, leaving all the moisture for the growing crop.

Whenever the rainfall is sufficient to more than supply the growing crop, another crop of vegetation may be grown between the rows and plowed under later, thereby improving the physical condition and increasing the water-holding capacity. The crops best suited for "green manuring" are those belonging to the leguminous family, as they are capable, when supplied with proper root bacteria, of obtaining nitrogen from the air and converting it into available plant food.

In Florida, where oranges are grown on sandy soil and the rainfall not very evenly distributed, the groves are cultivated frequently through the winter and spring (the dry season), then in the early summer, or at the beginning of the rainy season, the spaces between the rows are planted with velvet beans, cowpeas, or beggar weed, which is allowed to grow all summer. Often one crop is mowed and cured for hay and another crop will grow up. A small strip on each side of the tree is always cultivated and kept clean from weeds, even through the rainy season. Late in the fall the land is plowed, turning under

32551—No. 4—04——2

all the vegetable material; this, however, not before the crop has wilted, as it is generally believed that the plowing under of a green crop is not favorable to plant growth.

For cultivation, such implements as a toothed harrow, Acme harrow, spading harrow, and disk harrow are used, and the weeds are removed from around the trees with a hand hoe.

Crops, such as corn, vegetables, and pineapples, are not generally grown in orange groves, as they deplete the soil of fertilizing material necessary for the trees; and if heavily fertilized with organic nitrogen, such as is found in stable manure, dried blood, cotton-seed meal, tankage, etc., the orange tree is almost sure to contract the disease called "die-back." On Porto Rican soils it would also be safest not to use organic nitrogen in large quantities on orange trees until experiments shall have shown the effect.

WORKING OVER OLD TREES.

As orange growing in Porto Rico progresses from the semiwild conditions of to-day to up-to-date methods, it will become more and more apparent that the seedling must give way to the budded tree, and the sooner the seedling tree is worked over the more profitable it will be for the grower. It may seem wasteful to cut down a large tree bearing a comparatively good grade of fruit, but it is astonishing in how short a time the same tree will bear as large a crop of much finer fruit after working over.

There are several methods of working over old trees, and all of them require considerable skill, though some require much less time than others. Among these are crown grafting, top grafting, top budding, dormant budding, inarching, and bridge grafting.

CROWN GRAFTING.

In this method the tree is sawed off close to the ground, a scion of well-ripened wood 5 to 6 inches long and about three-eighths inch in diameter is then sharpened by a slanting cut on one side, similar to a sprig bud, and inserted on the stump between the bark and the wood, with the cut surface against the latter. If a concave place on the tree is selected and the bark carefully loosened with the budding knife it will stand the pressure of the scion without breaking and no wrapping will be necessary. On a large stump four to six scions should be inserted (Pl. III, fig. 2), and the whole top covered with wet clay, after which moist soil should be heaped up around, leaving but one eye of the scion projecting (fig. 2). A small amount of trash on the top will prevent the soil as well as the scion from drying out. In three or four weeks the scion will start growth and most of the soil should be removed. This method is probably easier than any of the following, but more time is lost in making a new tree.

FIG. 1.—TREE SAWED OFF FOR TOP GRAFTING.

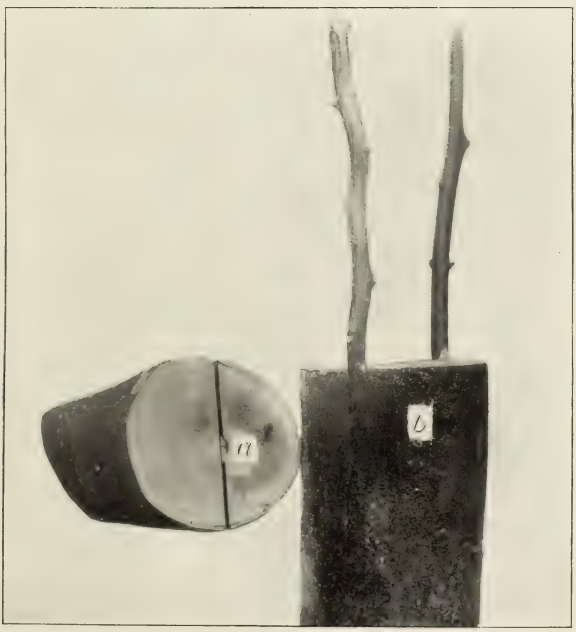


FIG. 2.—CLEFT GRAFTING: *a*, SHOWING THE CLEFT; *b*, GRAFTS INSERTED.

TOP GRAFTING.

The top of the tree is sawed off above the lowest branching, leaving a few inches of the lower limbs (Pl. IV, fig. 1) into which grafts may be inserted in a manner similar to the one described above. The grafts must be wrapped with twine or waxed tape and covered with a grafting wax or a mixture of wet clay and cow dung.[a]

A better method for grafting in the top is cleft grafting (Pl. IV, fig. 2). Here the limb is split through the center with a machete or sharp knife driven in with a hammer to the depth of about 2 inches. After withdrawing the knife a wedge should be inserted to keep the cleft open for the reception of the scion. The scion is then sharpened wedge-shaped by a slanting cut on each side, making one edge of the wedge a little thinner than the other. The wedge-shaped scion is then

FIG. 2.—Grafts covered up.

inserted into the cleft with the thinner edge of the wedge toward the center and the thicker side even with the bark of the limb. This will bring the growing tissue of scion and stock in close contact, which is absolutely essential for successful grafting. If the limb is small, one scion only should be inserted, and the limb firmly wrapped with twine, after which the whole top should be covered with grafting wax. If the limb is 3 inches or more in diameter the wrapping may be dispensed with, as the pressure will be great enough without.

[a] A good grafting wax may be made by melting together 2 pounds resin, 1 pound beeswax, and ¼ pound tallow. The melted mixture should be poured into a pail of cold water, after which it may be pulled and worked until nearly white. For working the mixture the hands should be greased to prevent sticking.

TOP BUDDING.

This method, while it requires more time, is after all the most satisfactory, as the new top will be formed in a very short time. The tree should be pruned so as to form a very open and symmetrical head, often requiring the removal of more than half of the branches (Pl. V). The pruning cut should always be clean and smooth and as close to the main branch as possible, in order that the wound may heal over and leave no unsightly scar. If a limb is chopped off with a machete and a stub of a few inches left, decay will usually gain entrance and the healing process will be slow. For pruning, the saw and shears (fig. 1) will be found very convenient. The cutting off of a large amount of growing wood will check the growth of the tree so as to tighten the bark, which will delay budding two or three weeks. Buds should therefore be inserted immediately after pruning. Often, however, the bark on the older branches will not slip, even if the tree is growing vigorously, and another method of budding will have to be employed.

DORMANT BUDDING.

As the name indicates, budding may be performed while the stock is dormant. A vertical cut is made parallel with the tree, loosening a narrow slice of bark about 1¼ inches long. Then, with a horizontal cut, ⅛ inch of the top end should be removed, leaving a bare space on the stock ⅛ inch long and a flap at the lower end ⅜ inch long. A shield bud is then cut in the usual way and inserted with the lower end under the loose piece of bark, by which it is held in place (Pl. VI, fig. 1). In wrapping, the operator should be careful not to displace the bud.

In about three weeks the budded branches may be girdled above the union, after which all the young growth below should be removed every week until no more appears. When the buds reach a size of ¾ inch in diameter the branches should be cut off with a slanting stroke close above the union, and the new tree will be formed. Such a tree will generally bear fruit two years after budding, and if well cared for will bear a large crop in four or five years.

INARCHING AND BRIDGE GRAFTING.

These two methods are seldom used in citrus propagation, but are often resorted to in case of accidents to the tree. If the tree is girdled by ants or the bark becomes diseased it may be restored by bridging the wound either with scions or with sprouts from the roots.

All the diseased bark should be removed and the edges of the girdle trimmed to healthy tissue. Scions of well-matured wood a few inches longer than the girdle should then be sharpened at both ends, cutting with a slanting stroke on one side. The ends should then be inserted above and below the girdle, through incisions made in the bark similar to those employed in shield budding (Pl. VI, fig. 2). All the insertions should then be wrapped with cord and carefully covered with grafting wax, and the exposed wood at the girdle should be cov-

TREE PRUNED FOR TOP BUDDING AND BRANCHES CUT OFF IMMEDIATELY ABOVE THE BUDS TO SHOW PLACES OF INSERTION.

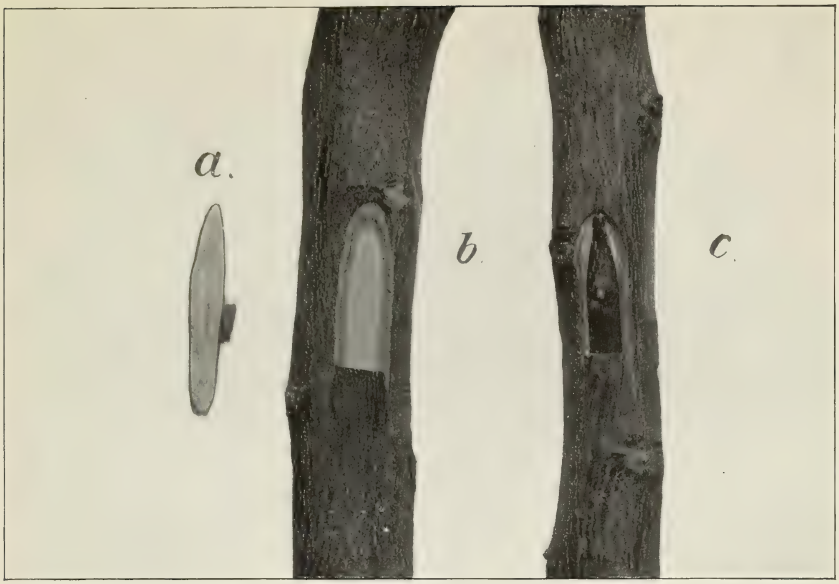


FIG. 1.—DORMANT BUDDING: *a*, BUD; *b*, PIECE OF BARK REMOVED; *c*, BUD INSERTED.

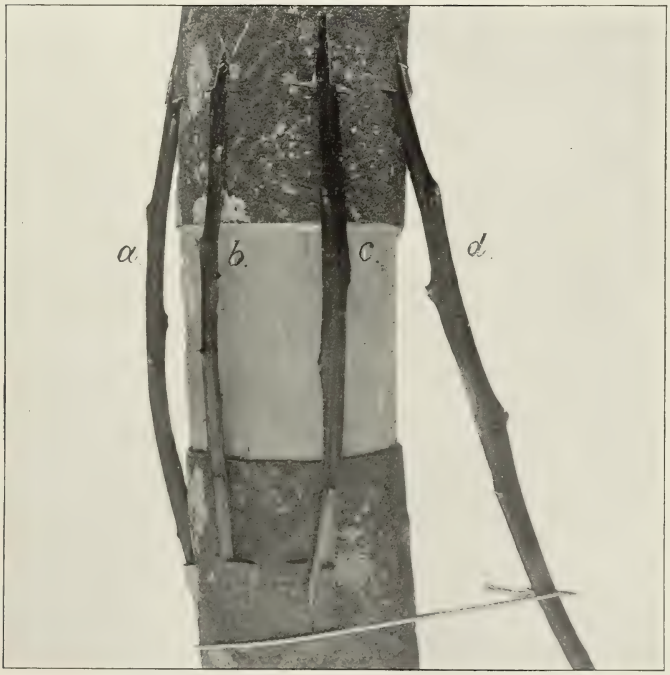


FIG. 2.—BRIDGE GRAFTING AND INARCHING: *a*, *b*, *c*, BRIDGE GRAFTS; *d*, INARCH.

ered with girdle paint, as described in Circular No. 4[a] of this station. Whenever a tree with healthy roots becomes partly or entirely girdled, sprouts will always spring up from the roots. Those sprouts when young can be cut, bent, and inserted above the girdle, and will grow very readily if held in close contact with the stock. For that purpose it should be tied to the stock with a cord and a fine wire nail driven in at the point of insertion, after which it should be wrapped in the usual way.

MARKETING.

A casual glance at the market quotations will show that Porto Rican oranges sell for much less than the Florida product, and it would be interesting to know why.

The commission man is apt to blame the packer, the packer will blame the shipping facilities as well as the grower, and the grower will blame them all. It should not be forgotten, however, that a great deal of blame rests with the grower himself. Most of the fruit shipped at the present time comes from seedling trees growing semi-wild within a few miles of the military roads or seaports. While some of the fruit is of extra good quality, a large percentage is inferior in flavor. The color is usually fairly good, but the peel is inclined to be rather rough. In picking, the stem is often pulled off and the fruit dropped to the ground. It is then transported several miles in sacks or baskets on horseback, or in bulk in ox carts, over a more or less rough road to the packing house. The packers do not always use the utmost care, and, of course, proper grading would be a difficult process under the circumstances. But more careful culling would certainly be advisable.

In shipping it takes at the present time from six to twelve days from the time of entering the steamer to the time of unloading, according to the port from which it is shipped. The ships have no cold-storage facilities, and the fruit is stored with other classes of goods. The foregoing will readily show that the fault is not with the quality of the fruit, and if the picking, curing, packing, and shipping is properly done, better prices may be expected. It will, however, require the best efforts of the commission man to overcome the present bad reputation.

PICKING AND CURING.

The fruit should never be pulled off, but should be separated from the branch by clipping the stem about one-eighth of an inch above the fruit. The picked fruit should never be dropped to the ground, but gathered in a sack or cloth-lined basket carried by the picker, and should then be emptied into shallow boxes or baskets. The fruit should always be handled as carefully as possible, remembering that every bruise may cause decay.

---

[a] Control of the Brown Ant in Orange Orchards.

The appearance of the fruit when ready to pick will vary with each variety. It may be said, however, always pick before fully colored up, but never so early that the fruit will not ripen en route, as a green orange will never sell well, regardless of other qualities.

Picking should never be done on a rainy day nor in the morning before the dew has dried. The fruit should always be "cured" (that is, the surplus water in the rind should be allowed to evaporate), which may be done by storing in a well ventilated house. The ideal way for this drying would be to spread the fruit out on shelves or on the floor so as to facilitate evaporation. That, however, is not practicable, as it necessitates extra handling, which will bruise the fruit more or less as well as increase the amount of work. The boxes or baskets containing the fruit may be removed from the field and stored in such a manner as to leave ample room for ventilation. If the sur-

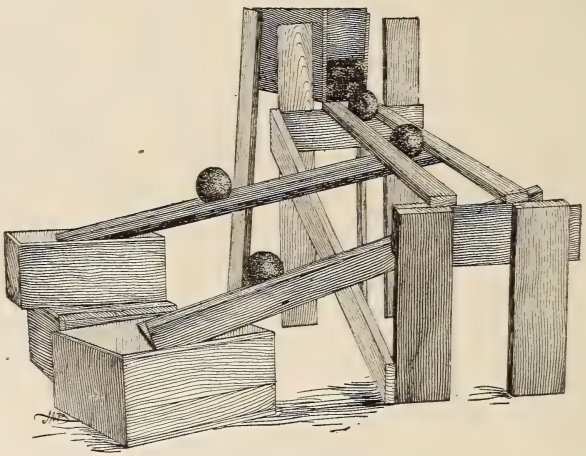


FIG 3.—Orange sizer.

rounding air is fairly dry two or three days will usually be sufficient for curing; otherwise, more time may be required.

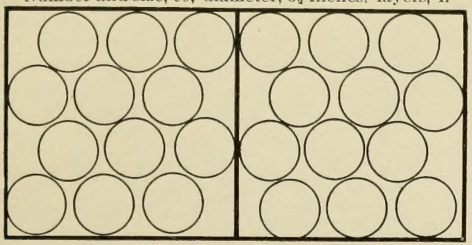
GRADING.

Every variety of fruit should be kept separate. Seedling trees should be graded according to the quality of fruit and given a number or mark. All the trees bearing fruit of the same quality should receive the same mark. The fruit from trees with different marks should be kept separate through the subsequent processes, and may then be packed like distinct varieties.

SIZING.

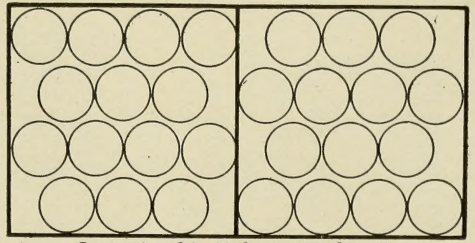
This work may be performed by machines of more or less intricate construction. The simplest orange sizer (fig. 3) consists of a triangular box, open at one corner, which is set inclined with the open corner

Number and size, 96; diameter, $3\frac{1}{4}$ inches: layers, 4.



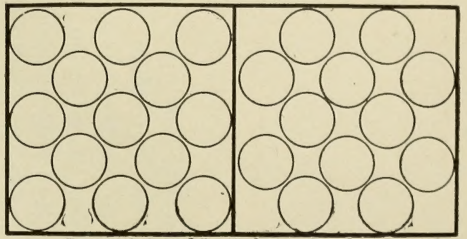
Layers 1 and 3—12; layers 2 and 4—12.

Number and size, 112; diameter, $3\frac{1}{4}$ inches; layers, 4.



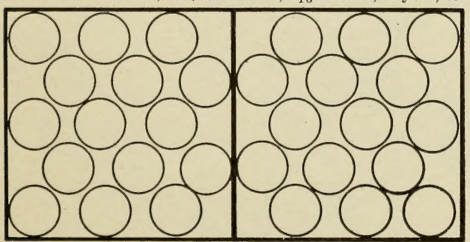
Layers 1 and 3—14; layers 2 and 4—14.

Number and size, 126; diameter, $3\frac{1}{8}$ inches; layers, 5.



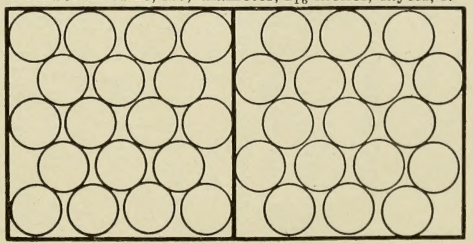
Layers 1, 3, and 5—13; layers 2 and 4—12.

Number and size, 150; diameter, $3\frac{1}{16}$ inches; layers, 5.



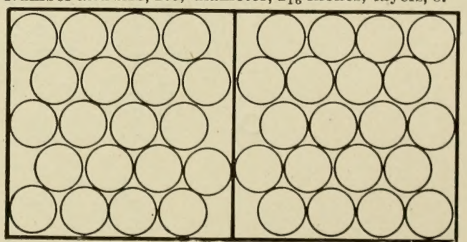
Layers 1, 3, and 5—15; layers 2 and 4—15.

Number and size, 176; diameter, $2\frac{15}{16}$ inches; layers, 5.



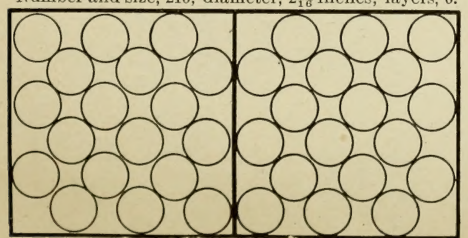
Layers 1, 3, and 5—18; layers 2 and 4—17.

Number and size, 200; diameter, $2\frac{13}{16}$ inches; layers, 5.



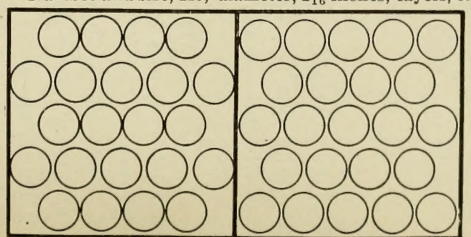
Layers 1, 3, and 5—20; layers 2 and 4—20.

Number and size, 216; diameter, $2\frac{1}{16}$ inches; layers, 6.



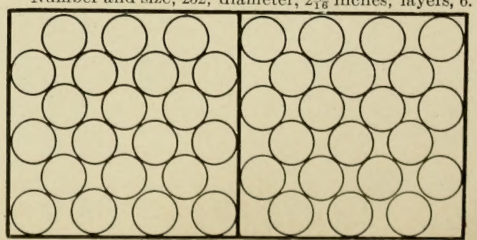
Layers 1, 3, and 5—18; layers 2, 4, and 6—18.

Number and size, 226; diameter, $2\frac{9}{16}$ inches; layers, 5.



Layers 1, 3, and 5—23; layers 2 and 4—22.

Number and size, 252; diameter, $2\frac{7}{16}$ inches; layers, 6.



Layers 1, 3, and 5—21; layers 2, 4, and 6—21.

FIG. 4.—Showing method of packing oranges (from Florida Sta. Bul. 63).

downward. An inclined plane should then be made consisting of two smooth pieces of wood about 2 inches in diameter and about 4 feet long, resting on two pairs of legs 15 inches and 27 inches high. The pieces should be nailed at one end onto the longer pair of legs with a distance of 1 inch between, and at the other end onto the shorter pair with a distance of 6 inches between. This runway should be placed under the triangular box so that oranges dropping from the opening will roll down its incline until they fall through. The distance between the pieces of the runway should be measured and every variation of $\frac{1}{8}$ inch should be marked. The smaller fruit will drop through where the opening is approximately $2\frac{1}{2}$ inches, and the very largest at 4 to $4\frac{1}{2}$ inches. Cloth-lined troughs should be placed underneath the sizer at intervals to catch the dropping fruit and convey it to boxes.

PACKING.

Oranges should be packed in boxes of standard size. The ones used in Florida are $12\frac{1}{2}$ by $12\frac{1}{2}$ by 27 inches, outside measure, with a partition in the middle. The packer should carefully examine every fruit and discard any that is in the least bruised, discolored, or deformed. The fruit should then be wrapped in tissue paper, which is sold especially for that purpose, and carefully packed in layers (fig. 4). The top layer should project about $\frac{3}{8}$ inch above the sides of the box, which will make the packing solid after the cover is nailed on under pressure. Every box should be stencilled on the end, stating the number of fruit, the grade or variety, and, if possible, the packer's name and address.

SHIPPING.

No fruit should be shipped out of Porto Rico unless it is of the very best quality and has been carefully graded and packed. A box of fruit generally sells in the market on the merit of the poorest specimens contained in it. A shipment of fruit does not, however, always sell on its merit, but will often bring a good price, even if it is slightly inferior, because of its good name, attained through many years of careful grading and honest packing. Therefore, grade closely, pack carefully, and ship no inferior fruit.

O